TECHNICAL EVALUATION REPORT

CONTROL OF HEAVY LOADS

BOSTON EDISON COMPANY

PILGRIM NUCLEAR POWER STATION

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FOREWORD

This Technical Evaluation Report was prepared by Franklin Research Center under a contract with the U.S. Nuclear Regulatory Commission (Office of Nuclear Reactor Regulation, Division of Operating Reactors) for technical assistance in support of NRC operating reactor licensing actions. The technical evaluation was conducted in accordance with criteria established by the NRC.

Mr. I. H. Sargent and Mr. C. Bomberger contributed to the technical preparation of this report through a subcontract with WESTEC Services, Inc.

1. INTRODUCTION

1.1 PURPOSE OF REVIEW

This technical evaluation report documents the review of general load handling policy and procedures at Boston Edison's Pilgrim Nuclear Power Station. This evaluation was performed with the following objectives:

- o to assess conformance to the general load handling guidelines of NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants" [1], Section 5.1.1
- o to assess conformance to the interim protection measures of NUREG-0612, Section 5.3.

1.2 GENERIC BACKGROUND

Generic Technical Activity Task A-36 was established by the U.S. Nuclear Regulatory Commission (NRC) staff to systematically examine staff licensing criteria and the adequacy of measures in effect at operating nuclear power plants to ensure the safe handling of heavy loads and to recommend necessary changes in these measures. This activity was initiated by a letter issued by the NRC staff on May 17, 1978 [2] to all power reactor licensees, requesting information concerning the control of heavy loads near spent fuel.

The results of Task A-36 were reported in NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants." The staff's conclusion from this evaluation was that existing measures to control the handling of heavy loads at operating plants, although providing protection from certain potential problems, do not adequately cover the major causes of load handling accidents and should be upgraded.

In order to upgrade measures for the control of heavy loads, the staff developed a series of guidelines designed to achieve a two-part objective using an accepted approach or protection philosophy. The first portion of the objective, achieved through a set of general guidelines identified in NUREG-0612, Section 5.1.1, is to ensure that all load handling systems at nuclear power plants are designed and operated so that their probability of failure is uniformly small and appropriate for the critical tasks in which they are employed. The second portion of the staff's objective, achieved through guidelines identified in NUREG-0612, Sections 5.1.2 through 5.1.5 is to ensure that, for load handling systems in areas where their failure might result in significant consequences, either (1) features are provided, in addition to those required for all load handling systems, to ensure that the potential for a load drop is extremely small (e.g., a single-failure-proof crane) or (2) conservative evaluations of load handling accidents indicate that the potential consequences of any load drop are acceptably small. Acceptability of accident consequences is quantified in NUREG-0612 into four accident analysis evaluation criteria.

A defense-in-depth approach was used to develop the staff guidelines to ensure that all load handling systems are designed and operated so that their probability of failure is appropriately small. The intent of the guidelines is to ensure that licensees of all operating nuclear power plants perform the following:

- define safe load travel paths through procedures and operator training so that, to the extent practical, heavy loads are not carried over or near irradiated fuel or safe shutdown equipment
- provide sufficient operator training, handling system design, load handling instructions, and equipment inspection to ensure reliable operation of the handling system.

Staff guidelines resulting from the foregoing are tabulated in Section 5 of NUREG-0612. Section 6 of NUREG-0612 recommends that a program be initiated to ensure that these guidelines are implemented at operating plants.

1.3 PLANT-SPECIFIC BACKGROUND

On December 22, 1980, the NRC issued a letter [3] to Boston Edison, the Licensee for the Pilgrim plant, requesting that the Licensee review provisions for handling and control of heavy loads, evaluate these provisions with respect to the guidelines of NUREG-0612, and provide certain additional information to be used for an independent assessment of conformance to these guidelines. On

June 25, 1981, Boston Edison provided the initial response [4] to this request. Additional information forwarded by the Licensee on October 8, 1981 [5] and July 13, 1983 [6] provides the basis for this technical evaluation.

2. EVALUATION

This section presents a point-by-point evaluation of load handling provisions at the Pilgrim plant with respect to NRC staff guidelines provided in NUREG-0612. Separate subsections are provided for both the general guidelines of NUREG-0612, Section 5.1.1 and the interim measures of NUREG-0612, Section 5.3. In each case, the guideline or interim measure is presented, Licensee-provided information is summarized and evaluated, and a conclusion as to the extent of compliance, including recommended additional action where appropriate, is presented. These conclusions are summarized in Table 2.1.

2.1 GENERAL GUIDELINES

The NRC has established seven general guidelines for the defense-in-depth approach to the handling of heavy loads. These guidelines consist of the following criteria from Section 5.1.1 of NUREG-0612:

Guideline 1 - Safe Load Paths
Guideline 2 - Load Handling Procedures
Guideline 3 - Crane Operator Training
Guideline 4 - Special Lifting Devices
Guideline 5 - Lifting Devices (Not Specially Designed)
Guideline 6 - Cranes (Inspection, Testing, and Maintenance)
Guideline 7 - Crane Design.

These seven guidelines should be satisfied for all overhead handling systems that handle heavy loads in the vicinity of the reactor vessel, near spent fuel in the spent fuel pool, or in other areas where a load drop may damage safe shutdown systems. The Licensee's verification of the extent to which these guidelines have been satisfied and the evaluation of this verification are contained in the succeeding paragraphs.

2.1.1 Overhead Heavy Load Handling Systems

a. Summary of Licensee Statements and Conclusions

The Licensee's review of handling systems in use at the Pilgrim plant identified the following systems to be within the scope of NUREG-0612:

Table 2.1. Pilgrim Station - NUREG-0612 Compliance Matrix

Heavy Loads	Weight or Capacity (tons)	Guideline 1 Safe Load Paths	Guideline 2 Procedures	Guideline 3 Crane Operator Training	Guideline 4 Special Lifting Devices	Guideline 5 Slings	Guideline 6 Crane - Test and Inspection	Guideline 7 Crane Design	Interim Measure 1 Technical Specifications	Interim Measure 6 Special Attention
1. Reactor Building Bridge Crane	100/5	--	--	C	--	--	C	C	--	--
a. Waste Debris Shipping Casks	20/10	C	C	--	--	C	--	--	--	--
b. Vessel Head Insulation	10	C	C	--	P	--	--	--	--	C
c. Crane Load Block	3	C	C	--	--	--	--	--	T	C
d. Cattle Chute	2	C	C	--	--	C	--	--	T	--
e. Stud Tensioner	0.5	C	C	--	--	C	--	--	--	--
f. Drywell Head Strongback	0.75	C	C	--	--	C	--	--	--	C
g. Heat Nut & Washer Racks (9)	0.6	C	C	--	--	C	--	--	--	--
h. Transfer Slot Stud Storage Rack	0.6	C	C	--	--	C	--	--	--	--
i. Reactor Head Strongback	2	C	C	--	--	C	--	--	--	C

C = Licensee action complies with NUREG-0612 Guideline.
P = Licensee action partially complies with NUREG-0612 Guideline.
T = Licensee action is technically equivalent to NUREG-0612 Guideline.
-- = Not applicable.

Table 2.1 (Cont.)

Heavy Loads	Weight or Capacity (tons)	Guideline 1 Safe Load Paths	Guideline 2 Procedures	Guideline 3 Crane Operator Training	Guideline 4 Special Lifting Devices	Guideline 5 Slings	Guideline 6 Crane - Test and Inspection	Guideline 7 Crane Design	Interim Measure 1 Technical Specifications	Interim Measure 6 Special Attention
j. Reactor Shield Plug (9)	68(3) 72(6)	C	C	--	P	--	--	--	--	C
k. Drywell Head	45	C	C	--	P	--	--	--	--	C
l. Reactor Vessel Head	80	C	C	--	P	--	--	--	--	C
m. Steam Dryers	27	C	C	--	--	C	--	--	--	C
n. Moisture Separator	47.5	C	C	--	--	C	--	--	--	C
o. Spent Fuel Pool Gates	5	C	C	--	P	C	--	--	T	--
p. Dryer/ Separator Storage Pit Shield Plug	43	C	C	--	P	C	--	--	--	--
q. Refueling Slot Plugs	4	C	C	--	P	C	--	--	--	--
r. Spent Fuel Shipping Casks	20	C	C	--	P	--	--	--	T	--
s. Vessel Service Platform	2	C	C	--	P	--	--	--	--	C

Table 2.1 (Cont.)

Heavy Loads	Weight or Capacity (tons)	Guideline 1 Safe Load Paths	Guideline 2 Procedures	Guideline 3 Crane Operator Training	Guideline 4 Special Lifting Devices	Guideline 5 Slings	Guideline 6 Crane - Test and Inspection	Guideline 7 Crane Design	Interim Measure 1 Technical Specifications	Interim Measure 6 Special Attention
2. Turbine Building Bridge Crane	165/25	C	C	C	P	C	C	C	--	--
3. RHR Pump and Motor Monorails	5	C	C	C	--	C	C	--	--	--
4. Recirc. Pump and Motor Monorails	20	C	C	C	--	C	C	--	--	--
5. Fuel Pool and RWCP Equipment Hatch Monorail	5	C	C	C	--	C	C	--	--	--
6. Reactor Aux. Bay Equipment Hatch Monorail	5	C	C	C	--	C	C	--	--	--
7. Recirc Pump MG Set Monorail	8	C	C	C	--	C	C	--	--	--

- reactor building bridge crane
- turbine building bridge crane
- residual heat removal (RHR) pump and motor hoist monorails
- recirculation pump and motor hoist monorails
- fuel pool and reactor water cleanup filter equipment hatch monorail
- reactor auxiliary bay equipment monorail
- recirculation pump MG set monorail.

Review of the remaining handling systems indicates that the following handling systems may be excluded from compliance with NUREG-0612 for the following reasons:

1. System lifting capacity is less than that defined to be a heavy load at the Pilgrim plant (1500 pounds):

    - channel handling boom
    - A and B refueling jib cranes
    - reactor building general area monorail.

2. The handling system is physically separated so that a load drop would not result in damage to fuel or systems required for safe shutdown:

    - fuel rod storage hoist
    - turbine basement hoist
    - radwaste area bridge crane
    - reactor cleanup sludge disposal bridge crane
    - offgas filter/shipping cask monorail
    - retention building prefilter monorail hoist
    - electric wire rope hoist
    - machine shop decontamination trough davit
    - turbine building mezzanine monorail.

In addition, the diesel generator monorails have been excluded on the basis that they are sole-purpose handling systems which can only be used when the respective generators are already out of service for maintenance. The feedwater heater A-frame and the reactor feed pump hoist have been excluded on the basis that although a load drop may damage cables associated with safe shutdown systems, loss of these cables would not result in an inability to accomplish safe shutdown.

b. Evaluation

Review of the Licensee's conclusions regarding overhead handling systems indicates that, with two exceptions, the Licensee's identification of those systems subject to compliance is consistent with the requirements of NUREG-0612. The exceptions noted are the feedwater heater A-frame and the reactor feed pump hoist. Although damage to the cables would not preclude safe shutdown, the intent of Phase I of NUREG-0612 is to include all handling systems which may damage systems required for safe shutdown, regardless of system redundancy or administrative limitations. Therefore, these two handling systems should also be subject to compliance with NUREG-0612.

c. Conclusion and Recommendations

The Licensee's conclusions regarding load handling systems subject to the general guidelines of Section 5.1.1 are consistent with the objectives of NUREG-0612 for those handling systems identified. However, the Licensee should reevaluate the feedwater heater A-frame and the reactor feed pump hoist for compliance with NUREG-0612 Phase I requirements.

2.1.2 Safe Load Paths [Guideline 1, NUREG-0612, Section 5.1.1(1)]

> "Safe load paths should be defined for the movement of heavy loads to minimize the potential for heavy loads, if dropped, to impact irradiated fuel in the reactor vessel and in the spent fuel pool, or to impact safe shutdown equipment. The path should follow, to the extent practical, structural floor members, beams, etc., such that if the load is dropped, the structure is more likely to withstand the impact. These load paths should be defined in procedures, shown on equipment layout drawings, and clearly marked on the floor in the area where the load is to be handled. Deviations from defined load paths should require written alternative procedures approved by the plant safety review committee."

a. Summary of Licensee Statements and Conclusions

The Licensee stated that safe load paths have been established for the reactor building bridge crane in accordance with Section 5.1.1(1) of NUREG-0612. These load paths are incorporated into various plant procedures and shown on equipment layout drawings.

b. Evaluation

An exclusion area in the turbine building has been established in which only certain loads may be carried. A safe load path has been established within this exclusion area for movement of these limited loads, as well as specific limits on the heights at which these loads may be carried. This safe load path was chosen so as to avoid damage to battery rooms A and B, which are located beneath the exclusion area.

The Licensee stated that load paths for monorails are defined by the limits of the monorail track. In one instance, however, the Licensee noted that additional limits were necessary: due to concern for damage of the CRD hydraulic control units below the 51-ft elevation deck, heavy load movements over the recirculation pump MG set monorail were limited in the event that heavy load movements are required during power operations. (However, no heavy load movements are anticipated during power operations, due to technical specification limits on the amount of time that a recirculation loop may be out of service.) Structural analyses have determined that it is necessary to impose administrative limits on heavy loads if they are moved in this area when operating at power.

The Licensee stated that the marking of load paths on operating floors is not practical due to the extensive use of temporary coverings on the floor during outages. However, as an alternative to floor markings, other visual aids are provided and are summarized as follows:

- o The crane operator/signalman will verify the load path clear of obstructions prior to load movement
- o The signalman will have in his possession, or will have reviewed prior to movement, the specific load path and will direct the crane operator along the designated path.

In addition, since heavy load handling procedures are safety-related, changes to these procedures (including load paths) are controlled and involve preparation of a safety evaluation, followed by review and approval by the Operations Review Committee (ORC).

b. Evaluation

From evaluation of the Licensee's response, it is apparent that the approach taken for safe load paths is consistent with the criteria of Guideline 1. Plant areas such as the reactor building, turbine building, and monorails have been individually evaluated. The load paths that have been generated in the reactor building satisfy guideline requirements. Use of an exclusion area in the turbine building is also consistent with guideline requirements since the exclusion area is a reasonably small, well-defined portion of the area and is incorporated in drawings and procedures. In addition, a safe load path has been established within the region which avoids safety-related equipment. Regarding monorails, it is agreed that definition of load paths is not necessary. Precautions which have been taken for the recirculation pump MG set monorail are appropriate and provide a degree of load handling reliability consistent with the guideline in the infrequent event that loads are handled in this area during power operations.

The Licensee's proposed use of signalmen who provide visual assistance to the crane operator is a suitable alternative to the marking of load paths on the floor. Lastly, the Licensee's response provides assurances that deviations to safe load paths receive appropriate control and supervision.

c. Conclusion

Safe load paths are developed and implemented at Pilgrim Unit 1 in a manner consistent with Guideline 1.

2.1.3 Load Handling Procedures [Guideline 2, NUREG-0612, Section 5.1.1(2)]

"Procedures should be developed to cover load handling operations for heavy loads that are or could be handled over or in proximity to irradiated fuel or safe shutdown equipment. At a minimum, procedures should cover handling of those loads listed in Table 3-1 of NUREG-0612. These procedures should include: identification of required equipment; inspections and acceptance criteria required before movement of load; the steps and proper sequence to be followed in handling the load; defining the safe path; and other special precautions."

a. Summary of Licensee Statements and Conclusions

The Licensee stated that procedures not only identify safe load paths, but also indicate the equipment needed, the proper steps to take in safe handling, and any special precautions necessary to fulfill the requirements of NUREG-0612, Section 5.1.1(2). In addition, the Licensee provided a breakdown of the loads handled, including approximate weight, size, frequency of handling, procedure, position relative to fuel, and the crane or special lifting device to be used.

b. Evaluation

Load handling procedures at the Pilgrim Nuclear Power Station meet the NUREG-0612 requirements. This evaluation is based on the Licensee's verification of compliance with the requirements of NUREG-0612, Section 5.1.1(2) and the provision of information to indicate that the loads listed in Table 3-1 of NUREG-0612 have been given consideration.

c. Conclusion

Procedures in use at Pilgrim Nuclear Power Station are consistent with the requirements of Guideline 2.

2.1.4 Crane Operator Training [Guideline 3, NUREG-0612, Section 5.1.1(3)]

"Crane operators should be trained, qualified and conduct themselves in accordance with Chapter 2-3 of ANSI B30.2-1976, 'Overhead and Gantry Cranes' [7]."

a. Summary of Licensee Statements and Conclusions

The Licensee stated that a training program has been implemented consisting of visual and verbal instruction followed by actual crane operation and performance appraisal. This training program is in accordance with Chapter 2-3 of ANSI B30.2-1976. Although all current operators of lifting equipment have had prior instruction and experience, all have taken or are to take the present training program. The physical requirements of Chapter 2-3 of ANSI B30.2-1976 are met and documented by Boston Edison's nuclear employees' physical examination.

b. Evaluation and Conclusion

The Pilgrim plant's crane operator training program is in accordance with NUREG-0612, Guideline 3 requirements on the basis of the Licensee's verification of full compliance with the requirements of ANSI B30.2-1976, Chapter 2-3.

2.1.5 Special Lifting Devices [Guideline 4, NUREG-0612, Section 5.1.1(4)]

"Special lifting devices should satisfy the guidelines of ANSI N14.6-1978, 'Standard for Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4500 kg) or More for Nuclear Materials' [8]. This standard should apply to all special lifting devices which carry heavy loads in areas as defined above. For operating plants certain inspections and load tests may be accepted in lieu of certain material requirements in the standard. In addition, the stress design factor stated in Section 3.2.1.1 of ANSI N14.6 should be based on the combined maximum static and dynamic loads that could be imparted on the handling device based on characteristics of the crane which will be used. This is in lieu of the guideline in Section 3.2.1.1 of ANSI N14.6 which bases the stress design factor on only the weight (static load) of the load and of the intervening components of the special handling device."

a. Summary of Licensee Statements and Conclusions

The Licensee identified the following special lifting devices to be subject to compliance with the requirements of NUREG-0612 and ANSI N14.6-1978:

- o head strongback
- o dryer/separator lifting sling assembly.

Evaluation of these devices with the criteria of ANSI N14.6-1978 was limited to Section 3.2 and parts of Section 5 for the following reasons:

1. These devices were designed by General Electric Company prior to the existence of ANSI N14.6-1978. In this regard, there are a number of sections in the standard that are not applicable in retrospect, including Designer's Responsibilities (3.1); Design Considerations (3.3); Fabricator's Responsibilities (4.1); Inspector's Responsibilities (4.2); and Fabrication Considerations (4.3). Because documentation is not available to assure that all of the

subparts of these sections were met, they have not been addressed item by item for the purpose of identifying and justifying exceptions. However, information on the design drawings indicates that sound engineering practices were placed on the fabricator and inspector by the designer for the purpose of assuring that the designer's intent was accomplished. On this basis, there is reasonable assurance that the intent of the sections of the standard listed above was, in fact, accomplished in the design, fabrication, inspection, and testing of these devices.

2. Several sections, including 1.0, Scope; 2.0, Definitions; 3.4, Design Considerations to Minimize Decontamination Effects in Special Lifting Device Use; 3.5, Coatings; 3.6, Lubricants; and 5.2.3, 5.3.4, and 4.3.5 related to functional testing of non-load-bearing parts are not pertinent to load handling reliability of the devices and therefore have not been addressed.

3. Section 6.0, Special Lifting Devices for Critical Loads, does not apply since the reactor building crane has not been upgraded to single-failure-proof.

The Licensee noted that design documents necessary to verify compliance or identify exceptions to these criteria are not available. However, it is the Licensee's opinion that adequate verification of the design safety margins has been demonstrated based upon the following:

1. Proof load tests to 125% of rated capacity were performed on both devices, followed by thorough visual, dimensional, and nondestructive examinations (NDE).

2. Both devices have performed numerous design lifts with no evidence of overstress or permanent deformation.

3. The possibility of an overload condition is extremely remote since each device is used only for the lift for which it was designed.

4. The devices are periodically subjected to necessary visual, dimensional, and NDE testing, which assures that any indication of overstress will be detected and corrected.

As a result of a comparison of the Pilgrim inspection, testing, and maintenance practices with Section 5 of ANSI N14.6-1978, it was noted that certain changes to plant procedures were required to satisfy the ANSI test and inspection requirements. These changes will be made so that the Licensee's inspection program complies fully, with the following exceptions:

Exception 1. Pilgrim special lifting devices will be periodically inspected in accordance with Section 5.3.1 of ANSI N14.6-1978. The

Licensee proposes that thorough visual inspections be conducted prior to each period of use, while the more thorough set of NDE will be performed on a 5-year interval. It is the Licensee's opinion that the extended 5-year frequency is warranted due to the limited frequency of use of these devices (typically once or twice per year) and the controlled environment in which they are stored.

Exception 2. On the basis that these devices have controlled storage, dedicated usage, and periodic inspections, the Licensee proposes performance of the periodic visual inspections by maintenance personnel on a prior-to-use basis rather than at 3-month or less intervals as prescribed by Section 5.3.7.

Exception 3. Section 5.3.3 requires that special lifting devices be load tested to 150% of maximum load following any incident of overstress or following permanent distortion of load-bearing parts. The Licensee notes that, in such an instance, distortion may have already occurred or defects may have already developed due to the overstresses. Therefore, it seems more prudent and practical to perform the dimensional testing and NDE to determine whether the device is still acceptable for use rather than to subject the device to 150% load testing. If major repairs are required, the device will be repaired or modified and the required testing will be performed.

Exception 4. The Licensee states that both special lifting devices were load tested to 125% of rated load, which is consistent with industry standards for other heavy lifting equipment and is judged by the Licensee to be adequate to demonstrate load carrying capacity substantially in excess of rated load.

b. Evaluation

In order to determine that design and use of special lifting devices are consistent with the criteria of ANSI N14.6-1978, the Licensee must demonstrate the following for each lifting device:

- o that design procedures, stress design factors, and fabrication controls were performed in a manner similar to that of ANSI N14.6-1978
- o that a proof load test was performed to document proof of workmanship of the device.
- o that a program of periodic load testing or detailed inspections is implemented to provide continued assurances that the lifting device will perform its intended task.

Information provided by the Licensee is sufficient to demonstrate compliance with the last two evaluation criteria, performance of a load test and implementation of a program to ensure continuing compliance. Exceptions taken by the Licensee are, for the most part, reasonable interpretations or alternatives to ANSI criteria which do not adversely affect the load handling reliability of the devices. Since these devices are used in periods that are routinely greater than 3 months, an inspection by maintenance personnel or non-operators prior to use meets the intent of the ANSI requirement. Relaxation of the inspection interval from a 1-year to a 5-year period is consistent due to the limited number of loading cycles each lifting device receives. A load test to 125% of rated load achieves the necessary verification that sound workmanship practices were used in the fabrication of these devices.

The following discussion applies to the Licensee's exception 3. If an overstress condition is known or suspected to have occurred (i.e., load hangup or overload), the reliability of the lifting device is in question. The primary purpose of the load test is to apply a given overload in a controlled fashion and for a specific time interval so that flaws and defects caused by the original overstress condition are allowed to propagate under controlled test conditions. Allowing the flaws to propagate will allow them to be more readily detected by NDE methods following the load test. Although NDE or visual examination of distorted members may identify obvious structural defects or distortion, NDE may not identify all defects prior to the load test. Such NDE may identify repairs or replacements of unsafe components which may be necessary in order to perform the required load test. Therefore, the Licensee's proposal to perform NDE prior to the load testing is acceptable to achieve this purpose but does not relieve the Licensee of the need to perform a thorough NDE following the load test.

Although sufficient information has been provided to document proof testing and programs for continuing compliance, information regarding design and fabrication controls is inadequate. A load test of 125% of the rated capacity does not provide adequate rationale to assume that design margins of 3 (on yield) and 4 (on ultimate stress) exist for these devices. Therefore, the Licensee should verify that design margins of these devices are consistent with ANSI criteria. Use of information contained in contractor's drawings, quality release documents, or performance of independent stress analysis may produce this information.

c. Conclusion and Recommendations

Programs for initial proof testing and for ensuring continuing compliance of special lifting devices at Pilgrim Unit 1 are consistent with the requirements of Guideline 4. A need for further Licensee action is required, however, to verify that design and fabrication of these devices was performed in a manner consistent with ANSI N14.6-1978.

2.1.6 Lifting Devices (Not Specially Designed) [Guideline 5, NUREG-0612, Section 5.1.1(5)]

"Lifting devices that are not specially designed should be installed and used in accordance with the guidelines of ANSI B30.9-1971, 'Slings' [9]. However, in selecting the proper sling, the load used should be the sum of the static and maximum dynamic load. The rating identified on the sling should be in terms of the 'static load' which produces the maximum static and dynamic load. Where this restricts slings to use on only certain cranes, the slings should be clearly marked as to the cranes with which they may be used."

a. Summary of Licensee Statements and Conclusions

The Licensee stated that all Pilgrim slings will be inspected, tested, repaired, and replaced in accordance with the applicable sections of ANSI B30.9-1971. In addition, heavy load handling procedures for all handling systems within the scope of NUREG-0612 require that sling selection be based upon applicable ANSI B30.9-1971 sections, including the following considerations:

- o an accurate designation of the load weight
- o addition of a dynamic load factor (0.5% of the load weight per foot per minute of hoist speed) to the load weight for specific hoists
- o selecting sling capacity based upon the combined load weight and dynamic load factor.

b. Evaluation and Conclusion

Selection and use of slings at Pilgrim Unit 1 is performed in a manner consistent with that required by Guideline 5.

2.1.7 Cranes (Inspection, Testing, and Maintenance) [Guideline 6, NUREG-0612, Section 5.1.1(6)]

"The crane should be inspected, tested, and maintained in accordance with Chapter 2-2 of ANSI B30.2-1976, 'Overhead and Gantry Cranes,' with the exception that tests and inspections should be performed prior to use where it is not practical to meet the frequencies of ANSI B30.2 for periodic inspection and test, or where frequency of crane use is less than the specified inspection and test frequency (e.g., the polar crane inside a PWR containment may only be used every 12 to 18 months during refueling operations, and is generally not accessible during power operation. ANSI B30.2, however, calls for certain inspections to be performed daily or monthly. For such cranes having limited usage, the inspections, test, and maintenance should be performed prior to their use)."

a. Summary of Licensee Statements and Conclusions

The Licensee stated that the crane inspection, testing, and maintenance requirements of NUREG-0612, Section 5.1.1(6) are adequately met by existing Pilgrim Nuclear Power Station maintenance procedures.

b. Evaluation and Conclusion

The Pilgrim crane inspection, testing, and maintenance program is in accordance with the requirements of Guideline 6 on the basis of the Licensee's verification of full compliance with NRC requirements.

2.1.8 Crane Design [Guideline 7, NUREG-0612, Section 5.1.1(7)]

"The crane should be designed to meet the applicable criteria and guidelines of Chapter 2-1 of ANSI B30.2-1976, 'Overhead and Gantry Cranes,' and of CMAA-70, 'Specifications for Electric Overhead Traveling Cranes' [10]. An alternative to a specification in ANSI B30.2 or CMAA-70 may be accepted in lieu of specific compliance if the intent of the specification is satisfied."

a. Summary of Licensee Statements and Conclusions

The Licensee noted that both the reactor building and turbine building bridge cranes were designed and fabricated in accordance with EOCI-61 "Specifications for Electric Overhead Traveling Cranes" (the predecessor to CMAA-70) and additional criteria contained in Bechtel specifications. In addition, the Licensee evaluated and addressed the more restrictive requirements of CMAA-70 regarding design and fabrication of these cranes.

1. Torsional forces. CMAA-70, Article 3.3.2.1.3 requires that twisting moments due to overhanging loads and lateral forces acting eccentric to the horizontal neutral axis of a girder be calculated on the basis of the distance between the center of gravity of the load, or force center line, and the girder shear center measured normal to the force vector. EOCI-61 states that such moments are to be calculated with reference to girder center of gravity. For girder sections symmetrical about each principal central axis (e.g., box section or I-beam girders commonly used in cranes subject to this review), the shear center coincides with the centroid of the girder section and there is no difference between the two requirements. Symmetrical box girders are used on both Pilgrim cranes, which are therefore in compliance with CMAA-70 requirements.

2. Longitudinal stiffeners. CMAA-70, Article 3.3.3.1 specifies (1) the maximum allowable web depth/thickness (h/t) ratio for box girders using longitudinal stiffeners and (2) requirements concerning the location and minimum moment of inertia for such stiffeners. EOCI-61 allows the use of longitudinal stiffeners but provides no similar guidance. Design and installation of longitudinal stiffeners for both cranes satisfy the CMAA-70 requirements.

3. Allowable compressive stress. CMAA-70, Article 3.3.3.1.3 identifies allowable compressive stresses of approximately 50% of yield strength of the recommended structural material (A-36) for girders, where the ratio of the distance between web plates to the thickness of the top cover plate (b/c ratio) is less than or equal to 38. Allowable compressive stresses decrease linearly for b/c ratios in excess of 38. EOCI-61 provides a similar method for calculating allowable compressive stresses except that the allowable

stress decreases from approximately 50% of yield only after the b/c ratio exceeds 41. The ratios of b/c for the reactor and turbine building cranes are 16 and 10.5, respectively, and therefore EOCI-61 and CMAA-70 design requirements are the same.

4. Fatigue considerations. CMAA-70, Article 3.3.3.1.3 provides substantial guidance with respect to fatigue failure by indicating allowable stress ranges for various structural members in joints under repeated loads. EOCI-61 does not address fatigue failure. The requirements of CMAA-70 are not expected to be of consequence for cranes subject to this review since the cranes are not generally subjected to frequent loads at or near design conditions (CMAA-70 provides allowable stress ranges for loading cycles in excess of 20,000) and are not generally subjected to stress reversal (CMAA-70 allowable stress range is reduced to below the basic allowable stress for only a limited number of joint configurations). The reactor and turbine building cranes will experience less than 2,000 and 13,200 cycles, respectively; therefore, fatigue failure should not be of concern for either crane.

5. Hoist rope requirements. CMAA-70, Article 4.2.1 requires that the capacity load plus the bottom block divided by the number of parts of rope not exceed 20% of the published rope breaking strength. EOCI-61 requires that the rated capacity load divided by the number of parts of rope not exceed 20% of the published rope breaking strength. Information provided by the Licensee indicates that hoist rope safety factors are all greater than 5 when the combined weight of the load block and rated capacity are considered.

6. Drum design. CMAA-70, Article 4.4.1 requires that the drum be designed to withstand combined crushing and bending loads. EOCI-61 requires only that the drum be designed to withstand maximum load, bending and crushing loads, with no stipulation that these loads be combined. Combined bending and crushing loads were considered in design of both Pilgrim cranes.

7. Drum design. CMAA-70, Article 4.4.3 provides recommended drum groove depth and pitch. EOCI-61 provides no similar guidance. Actual groove depth and pitch for the reactor and turbine building crane hoists comply with CMAA-70 criteria.

8. Gear design. CMAA-70, Article 4.5 requires that gearing horsepower rating be based on certain American Gear Manufacturers Association Standards and provides a method for determining allowable horsepower. EOCI-61 provides no similar guidance. Boston Edison's Reactor Crane Specification 6498-M-23, Section 3.3.6 satisfies this requirement.

9. Bridge brake design. CMAA-70, Article 4.7.2.2 requires that bridge brakes, for cranes with cab control and the cab on the trolley, be rated for at least 75% of bridge motor torque. EOCI-61 requires a brake rating of 50% of bridge motor torque for similar configurations. Boston Edison's Reactor Crane Specification 6498-M-23, Section 3.4.3 satisfies the CMAA-70 requirement.

10. Hoist brake design. CMAA-70, Article 4.7.4.2 requires that hoist holding brakes, when used with a method of a control braking other than mechanical, have torque ratings no less than 125% of the hoist motor torque. EOCI-61 requires a hoist holding brake torque rating of no less than 100% of the hoist motor torque without regard to the type of control brake employed. Hoist holding brakes for all reactor and turbine crane hoists are rated in excess of 150% of the hoist motor torque and therefore comply with CMAA-70 requirements.

11. Bumpers and stops. CMAA-70, Article 4.12 provides substantial guidance for the design and installation of bridge and trolley bumpers and stops for cranes which operate near the end of bridge and trolley travel. No similar guidance is provided in EOCI-61. Boston Edison's Reactor Crane Specification 6498-M-23, Section 3.1.7 satisfies the CMAA-70 requirement.

12. Static control systems. CMAA-70, Article 5.4.6 provides substantial guidance for the use of static control systems. EOCI-61 provides guidance for magnetic control systems only. This issue is not of consequence since magnetic controls were used on both Pilgrim cranes.

13. Restart protection. CMAA-70, Article 5.6.2 requires that cranes not equipped with spring-return controllers or momentary-contact pushbuttons be provided with a device that will disconnect all motors upon power failure and will not permit any motor to be restarted until the controller handle is brought to the OFF position. No similar guidance is provided in EOCI-61. The

reactor building crane is provided with spring-return pushbutton controls; the turbine building crane cab-control circuitry includes an undervoltage release which prevents motor restart unless cab master switches are in neutral, while the pendant control station is provided with spring-return pushbuttons.

b. Evaluation

Cranes at Pilgrim Nuclear Power Station substantially satisfy the criteria of Guideline 7 on the basis that they were originally procured to EOCI-61. In addition, the Licensee has performed a comparison of existing crane design with the more restrictive criteria of CMAA-70 and has determined that these cranes also comply with CMAA-70.

c. Conclusion

Design of cranes at Pilgrim Unit 1 is consistent with the criteria of Guideline 7.

2.2 INTERIM PROTECTION MEASURES

The NRC has established six interim protection measures to be implemented at operating nuclear power plants to provide reasonable assurance that no heavy loads will be handled over the spent fuel pool and that measures exist to reduce the potential for accidental load drops to impact on fuel in the core or spent fuel pool. Four of the six interim measures of the report consist of Guideline 1, Safe Load Paths; Guideline 2, Load Handling Procedures; Guideline 3, Crane Operator Training; and Guideline 6, Cranes (Inspection, Testing, and Maintenance). The two remaining interim measures encompass the following criteria:

1. Heavy load technical specifications
2. Special review for heavy loads handled over the core.

The status of the Licensee's implementation and FRC's evaluation of these interim protection measures are summarized in the succeeding paragraphs of this section.

2.2.1 Technical Specifications [Interim Protection Measure 1, NUREG-0612, Section 5.3(1)]

"Licenses for all operating reactors not having a single-failure-proof overhead crane in the fuel storage pool area should be revised to include a specification comparable to Standard Technical Specification 3.9.7, 'Crane Travel - Spent Fuel Storage Pool Building,' for PWR's and Standard Technical Specification 3.9.6.2, 'Crane Travel,' for BWR's, to prohibit handling of heavy loads over fuel in the storage pool until implementation of measures which satisfy the guidelines of Section 5.1."

a. Summary of Licensee Statements and Conclusions

The Licensee stated that no technical specification currently exists that prohibits movement of heavy loads over spent fuel in the spent fuel pool. However, current plant procedures define specific load paths for heavy loads handled in the vicinity of the spent fuel pool. With the exception of two loads (casks and the spent fuel gate) which are carried over peripheral areas of the pool, the Licensee stated that no other heavy loads pass over the spent fuel pool. Load paths have been developed for the two exceptions noted such that the loads do not pass directly over spent fuel in the spent fuel pool. In addition, the Licensee noted that it may be necessary to periodically move the reactor building crane load block over this area: redundant upper limit switches will be provided in addition to the existing redundant brakes to ensure that the probability of two-blocking or uncontrolled lowering will be sufficiently small. The Licensee stated that these are safety-related procedures and deviations are tightly controlled; therefore, no additional procedures or technical specifications are judged to be necessary.

b. Evaluation

Although no technical specification prohibiting movement of heavy loads over spent fuel in the spent fuel pool exists, administrative controls which have been implemented provide a comparable degree of protection for spent fuel. Further, information forwarded by the Licensee in response to Guidelines 1 and 2 provides additional assurances that these procedures and load movements will be adequately supervised and that deviations to established load paths will receive proper evaluation and approval.

c. Conclusion

The use of well-defined administrative controls at Pilgrim Unit 1 provides a degree of load handling protection equivalent to that contained in Interim Protection Measure 1.

2.2.2 Administrative Controls [Interim Protection Measures 2, 3, 4, and 5, NUREG-0612, Sections 5.3(2)-5.3(5)]

"Procedural or administrative measures [including safe load paths, load handling procedures, crane operator training, and crane inspection]... can be accomplished in a short time period and need not be delayed for completion of evaluations and modifications to satisfy the guidelines of Section 5.1 of [NUREG-0612]."

a. Summary of Licensee Statements and Conclusions

Summaries of Licensee statements and conclusions are contained in discussions of the respective general guidelines in Sections 2.1.2, 2.1.3, 2.1.4, and 2.1.7 of this report.

b. Evaluations, Conclusions, and Recommendations

Evaluations, conclusions, and recommendations are contained in discussions of the respective general guidelines in Sections 2.1.2, 2.1.3, 2.1.4, and 2.1.7 of this report.

2.2.3 Special Reviews for Heavy Loads Over the Core [Interim Protection Measure 6, NUREG-0612, Section 5.3(1)]

"Special attention should be given to procedures, equipment, and personnel for the handling of heavy loads over the core, such as vessel internals or vessel inspection tools. This special review should include the following for these loads: (1) review of procedures for installation of rigging or lifting devices and movement of the load to assure that sufficient detail is provided and that instructions are clear and concise; (2) visual inspections of load bearing components of cranes, slings, and special lifting devices to identify flaws or deficiencies that could lead to failure of the component; (3) appropriate repair and replacement of defective components; and (4) verify that the crane operators have been properly trained and are familiar with specific procedures used in handling these loads, e.g., hand signals, conduct of operations, and content of procedures."

a. Summary of Licensee Statements and Conclusions

The Licensee stated that a review of plant procedures has been performed and it has been confirmed that sufficient detail and clarity are provided for the subjects of interest. Compliance with interim measures for visual inspections of load bearing components, appropriate repair and replacement of defective components, and verification of operator training may be found in the Licensee's responses to Guidelines 2 through 7.

b. Evaluation and Conclusion

Review of the Licensee's responses indicates that appropriate review and inspection of load handling practices and equipment have been performed to satisfy the requirements of this guideline.

3. CONCLUSION

This summary is provided to consolidate the results of the evaluation contained in Section 2 concerning individual NRC staff guidelines into an overall evaluation of heavy load handling at Pilgrim Nuclear Power Station. Overall conclusions and recommended Licensee actions, where appropriate, are provided with respect to both general provisions for load handling (NUREG-0612, Section 5.1.1) and completion of the staff recommendations for interim protection (NUREG-0612, Section 5.3).

3.1 GENERAL PROVISIONS FOR LOAD HANDLING

The NRC staff has established seven guidelines concerning provisions for handling heavy loads in the area of the reactor vessel, near stored spent fuel, or in other areas where an accidental load drop could damage equipment required for safe shutdown or decay heat removal. The intent of these guidelines is twofold. A plant conforming to these guidelines will have developed and implemented, through procedures and operator training, safe load travel paths such that, to the maximum extent practical, heavy loads are not carried over or near irradiated fuel or safe shutdown equipment. A plant conforming to these guidelines will also have provided sufficient operator training, handling system design, load handling instructions, and equipment inspection to ensure reliable operation of the handling system. As detailed in Section 2, it has been found that load handling operations at Pilgrim Nuclear Power Station can be expected to be conducted in a reliable manner consistent with the staff's objectives as expressed in these guidelines.

To ensure that the overall intent of NUREG-0612, Section 5.1.1 is satisfied, the Licensee should perform the following:

- o Develop a program consistent with ANSI N14.6-1978, Section 5.0, to maintain the assurance of reliability of special lifting devices.

3.2 INTERIM PROTECTION

The NRC staff has established in NUREG-0612, Section 5.3 certain measures that should be initiated to provide reasonable assurance that handling of heavy loads will be performed in a safe manner until final implementation of the general guidelines of NUREG-0612, Section 5.1 is complete. Specified measures include the implementation of a technical specification to prohibit the handling of heavy loads over fuel in the storage pool; compliance with Guidelines 1, 2, 3, and 6 of NUREG-0612, Section 5.1.1; a review of load handling procedures and operator training; and a visual inspection program, including component repair or replacement, as necessary, of cranes, slings, and special lifting devices to eliminate deficiencies that could lead to component failure. Evaluation of information provided by the Licensee indicates that the NRC staff's measures for interim protection are met at the Pilgrim Nuclear Power Station.

4. REFERENCES

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4. A. V. Morisi (BE)
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8. ANSI N14.6-1978
   "Standard for Special Lifting Devices for Shipping Containers Weighing
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10. CMAA-70
    "Specifications for Electric Overhead Traveling Cranes"
    Crane Manufacturers Association of America, 1975

11. EOCI-61
    "Specifications for Electric Overhead Traveling Cranes"
    Electric Overhead Crane Institute, 1961